

Research Article

Behavioural Patterns and Activity Budgeting of Greater Flamingo, *Phoenicopterus roseus* in Najafgarh Jheel Bird Sanctuary (Drain), Haryana, India

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ABSTRACT

Activity pattern performed by Greater Flamingos was studied at Najafgarh Jheel Bird Sanctuary from November 2018 to November 2019. During present study different type of behaviours was recorded, and frequency calculated for a different type of behaviours performed among months as well as different time block (morning, afternoon, evening) for adult and immature. A total of 117 hrs were spent in recording activity budget study. Scan sampling and focal sampling methods were adopted to collect the data. A number of behavioural categories, resting (one leg- standing, broken neck posture), preening (twist preen), feeding, alert, aggression (such as chrysanthemum / Threatening, hooking and ritual bickering), movement (marching, flight, walking), wing-salute, inverted wing salute, wing-leg stretching, scratching, drinking, bathing, wing flapping and combat identified. The result revealed that the main behaviours were Feeding, resting and preening. Resting was maximum at morning hours while feeding at its peak during evening hours. Greater Flamingos found to be engaged in feeding (47.16 % ± 1.34) followed by resting (23.85 ± 1.08 %), preening (14.09 ± 0.33 %) movement (6.98 ± 0.76 %) alert (3.30 ± 0.12 %) and aggression (1.44 ± 0.13 %).

Key words: Activity Budgeting; Flamingo; *Phoenicopterus roseus*, Najafgarh Drain; Haryana; Behaviour; Feeding; Resting

INTRODUCTION

Greater Flamingos are known to be a flagship species of Mediterranean wetlands (Deville, *et al.*, 2013). Flamingos are sociable birds and found to be live in flocks, their flocks may range from a few to thousands which often known as “Pat” (Tere, 2005; Johnson & Cezilly, 2007). During the non-breeding season, flamingos gathered in large flocks (Allen, 1956). The word “Flamingo” is a Latin word that means Flame (Sumathi, 2008). The lakes which having a high concentration of salt or being more alkaline or saline are most preferred by flamingos for feeding (Grimmett, 1998; Sumathi, 2008; Del Hoyo *et al.*, 2017). A vast variety of wetlands from tidal mudflats and stream deltas to inland lakes use them for foraging (Johnson & Cezilly, 2007). Their bright colouration, hooked bills and large body size is helpful for their easy recognition which is quite brownish in chicks and juveniles (Johnson & Cezilly, 2007; Sumathi, 2008). Food accessibility is one of the important factors which influenced Flamingos distribution (Jenkin, 1957). In India Greater Flamingos are mainly seen to occur in Gujarat, Orissa, Assam, Maharashtra, Kerala, Uttar Pradesh, Rajasthan and Tamil Nadu (Rao, 1983; Tere, 2005; Ramesh & Ramachandran, 2005; Sumathi, 2008; Arjun & Roshnath, 2018).

The time budget is the proportion of time spent on various mutually exclusive activities by individual animals, which be contingent on intra- and interspecific

interaction, and the prevailing abiotic environment (Willmere, *et al.*, 2005). Activity rhythm and time budgeting are directly associated with animal’s metabolism and thus is often a crucial part to conduct ecology research (Halle & Stenaeth, 2000). Time budgeting quantitative describes how animals utilize their time for various activities like feeding, maintenance and breeding activities (Baidassarre & Bolen, 1994). The proportion of time and energy devoted by birds to perform various activities must inevitably affect their survival (Orians, 1961). Time spent in various activities by birds is highly vast according to the use of food and habitat type (Paulus, 1984). The activity budgeting was studied in many species of water birds specifically geese (Raveling, *et al.*, 1972; Marquiss & Ducan, 1994); ducks (Baldassarre & Bolen, 1994); wader (Boettcher & Haig, 1994; and in Lesser Flamingos (Rameshchandra, 2014).

The time budget studies are a useful tool for determining patterns of habitat use, resource exploitation, and variables that restrict survival (Khan, 2014). Understanding of daily activity patterns of birds is crucial to know their ability to adapt to current habitat and human interference. The energy distribution and survival rate of birds depend on their activity patterns and time budgets. (Maheswaran & Rahmani, 2007). To explore conservation scenarios for endangered birds, particularly for fledglings, the features of habitat, daily activity pattern, and home range size must be known (Xu, *et al.*, 2021).

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Furthermore, an activity budget analysis of any migratory species can provide an understanding of the significance of seasonal usage of habitats. Species activity budgets, along with habitat assessments, have proved beneficial in developing appropriate conservation strategies and management programs in many areas of the world (Paulus, 1988). The current study is designed to give a better knowledge of the energy expenditure of the Greater Flamingos populations, which will assist enhance the species long-term conservation and management plan.

This study aimed to determine preliminary information related to various social as well as egocentric behaviour of the Greater Flamingo and to provide details on the activity time budgeting of the Greater Flamingo. Activity budgeting has been identified as a vital tool to know about habitat use as well as niche separation (Rave & Baldassarre, 1989) and thus it can be utilized as an important tool for the management of bird's habitat. Many behavioural categories were identified.

The result shows that the main behaviours were feeding, resting and preening.

MATERIALS AND METHODS

Study Area

The study was conducted at Najafgarh Jheel Bird Sanctuary (Figure 1) which is located $28^{\circ} 30' 09.36''$ N, $76^{\circ} 56' 44.68''$ E with elevation of 211 meters. The Najafgarh Jheel also known as Najafgarh Drain is situated at the Delhi-Haryana border, is estimated to be 7 Km long and is part dying Sahibi river that originates in the Aravalis on the border of Rajasthan-Haryana. Most of the area covered by Najafgarh Jheel Bird Sanctuary falls in two villages namely Kherki Majra and Dhankot which is about 120.80 hectares, in the Gurugram district of Haryana. As the untreated sewage flows into it, which makes the Jheel is one of the most polluted even though it is also an important habitat of many birds and plants species.

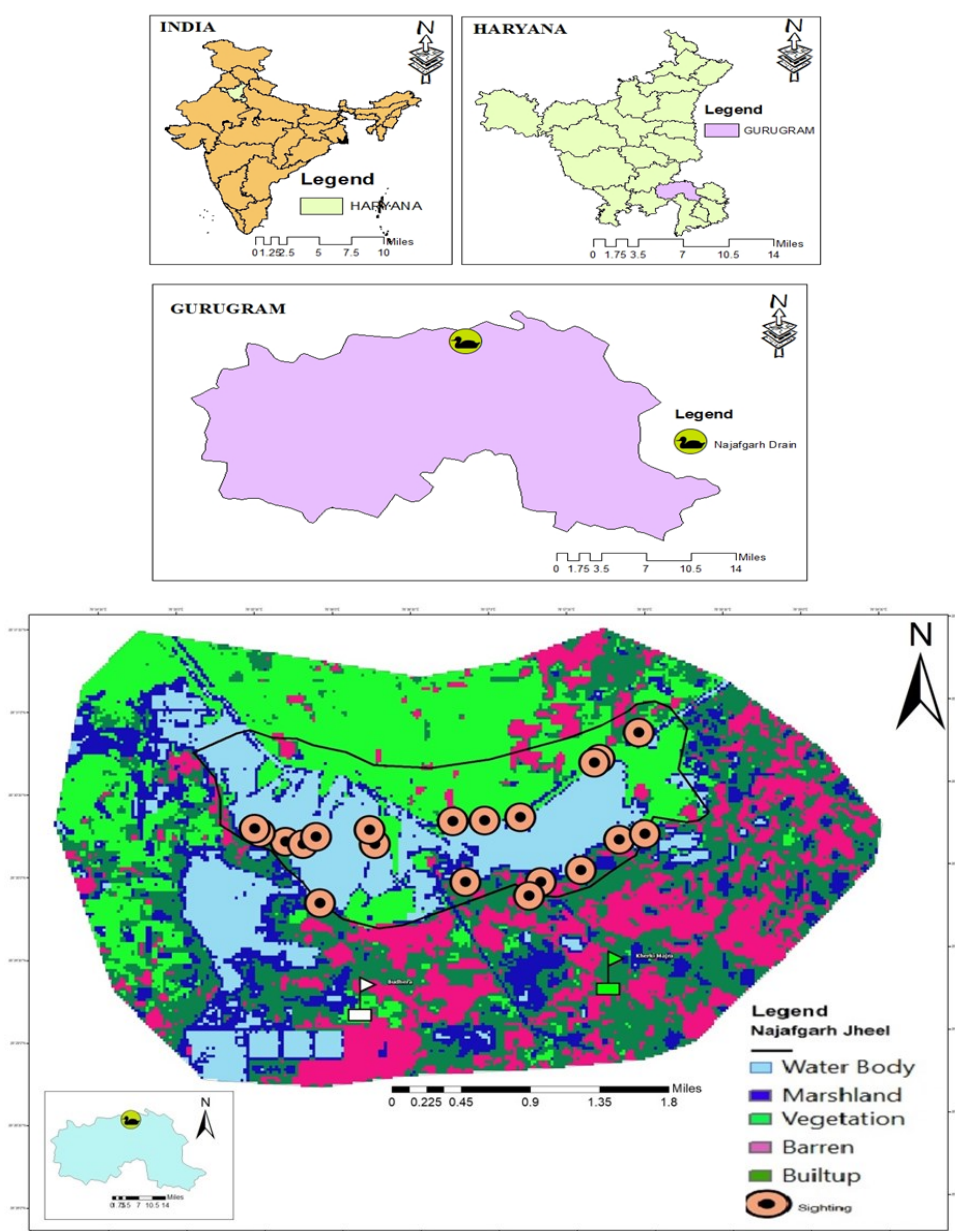


Figure 1. Map showing the location of Najafgarh Jheel Bird Sanctuary The land use and land cover of study sites in the Gurugram region was assessed on 14-10-2020.

The study was carried out from November 2018 to November 2019. The location of the flocks of Flamingos was recorded by using a hand-held GPS device. Various behavioural patterns of Nonbreeding Greater Flamingos were noted at Najafgarh Jheel Bird Sanctuary throughout the study period. To know about the various diurnally activity undertaken by Greater Flamingo in the study area, a preliminary observation was made to be familiarized with the study subject as well as their different activity patterns (Altmann, 1974). Observations were carried with a Nikon 10 X 50 field binocular and the time taken in each activity was determined by a stopwatch. Various body posture of Greater Flamingo was recorded through scan sampling and focal sampling (Altmann, 1974). The focal animal sampling method was used to collect data of diurnally activity budgeting (Altmann, 1974; Martin & Bateson, 2007). Each day was divided into three-time blocks: morning (9.00- 11.00), afternoon (1.00- 3.00), and evening (4.00- 6.00) and observations were made in each time block for the different behavioural pattern was as follows: every hour of each time block used to be subdivided into three 15-minute continuous observation periods, pursued by way of a 5-minute break.

Depending upon characteristics of their plumage adults and immatures (sub-adults) were distinguished from each other (Allen, 1956; Johnson & Cezilly, 2007). And differences in various activity patterns were also noted among adults and immatures separately (Figure-4). Videography and still photography were also used to monitor a variety of activity patterns which were identified later. Various activities are divided into the

following major category (table-1) terminology of Ogilive & Ogilive, (1986); Johnson & Cezilly, (2007) and Tere, (2005) are used to define the various activity pattern in Greater Flamingos.

Time used in performing various activities was calculated every single month and also estimated percentages of the time spent for performing different activities throughout the day as well as different time blocks of the day.

Data analysis

Different activity pattern of Greater Flamingos was compared among different time block of the day and months for adult and immature (sub-adult) separately using analysis of variance. All statistical analysis was carried by using excel and IBM SPSS 23.

RESULTS

A total of 117 hrs were spent in recording activity budget study of adult and immature respectively. An ethogram is considered as a set of behavioural classes that are used to describe a species 'behaviour (Table 1) (Haccou & Meelis, 1992). During the present study several behavioural categories, resting (one leg- standing, broken neck posture), preening (twist preen), feeding, alert, aggression (such as chrysanthemum, hooking and ritual bickering), movement (marching, flight, walking), wing-salute, inverted wing salute, wing-leg stretching, scratching, broken neck posture, drinking, bathing, wing flapping and combat identified (as shown in Figure 2).

Table 1. Greater Flamingo Behavioural Ethogram of the study: showing names and definitions of various behaviours observed frequently.

BEHAVIOURAL CATEGORIES	DESCRIPTION
Preening	Flamingos twist their head and preen on both sides of the body one after another side using their bill.
Twist- preen	The birds turned their head and neck on one side in a sudden movement, falling down their wings on the same side and seeming to be preening behind the wing. This movement is repeated individually while switching sides.
Wing-leg stretch	This lasts about 1 -2 seconds the birds extend a wing and a leg from a similar side of their body very much like throughout comfort movement.
Scratching	The bird scratches its neck utilizing one of its legs just behind the chin in the lowered position.
Combat	Face to face ritual fought.
Walking	They walk, sometimes head flagging at the same time.
Wing-salute	The flamingo stand with starched neck and head held up and they open their wings up to a full extent.
Inverted wing salute	In this behaviour flamingos partially open their wing, they bent forwardly from an erect posture so their tail is higher than the chest.
Resting	During resting they normally stand on one leg and their other leg tucked under feathers. They twist their neck for rest on their back feathers.
Head Flagging	Flamingo flags their head jerkily from side to side with stretched neck.
Alert	The Flamingo stand erects keeping their neck extended upward, with their tail somewhat bent downward.
Marching	The flocks of flamingos walk rapidly in one direction and then suddenly change their direction, simultaneously shows a murmur. This happens synchronously.
Other behaviours	Other behaviour may include Ritual Bickering, Chrysanthemum/threatening, hooking, broken neck posture, drinking, bathing sleeping etc.



Figure 2. Different Behaviour Patterns of Greater Flamingos observed at the Study site.

The activity pattern of Greater Flamingos was markedly different throughout different time blocks of the day (Figure-3). Feeding resting and preening were the main activities of Non-breeding Greater Flamingos, throughout the different time blocks of the day. They were found to be engaged over 84% of their diurnal time in performing these activities. Greater Flamingos found to be engaged in feeding (47.16 ± 1.34 %) followed by resting (23.85 ± 1.08 %), preening (14.09 ± 0.33 %), movement (6.98 ± 0.76 %), alert (3.30 ± 0.12 %) and aggression (1.44 ± 0.13 %) respectively.

It was observed that resting was lowest at evening hours (12.39 ± 2.25), while it was on the peak at morning hours (33.69 ± 5.57), and feeding was least at morning hours (34.81 ± 4.68), and at its peak at evening hours (61.02 ± 5.18), (Figure 3). Figure 4 showing the relative percentage of different types of activity shown by adult and immature (sub-adult) Greater Flamingos. Adult and immature both were found to be engaged most of their diurnal time in feeding followed by resting (Figure 2).

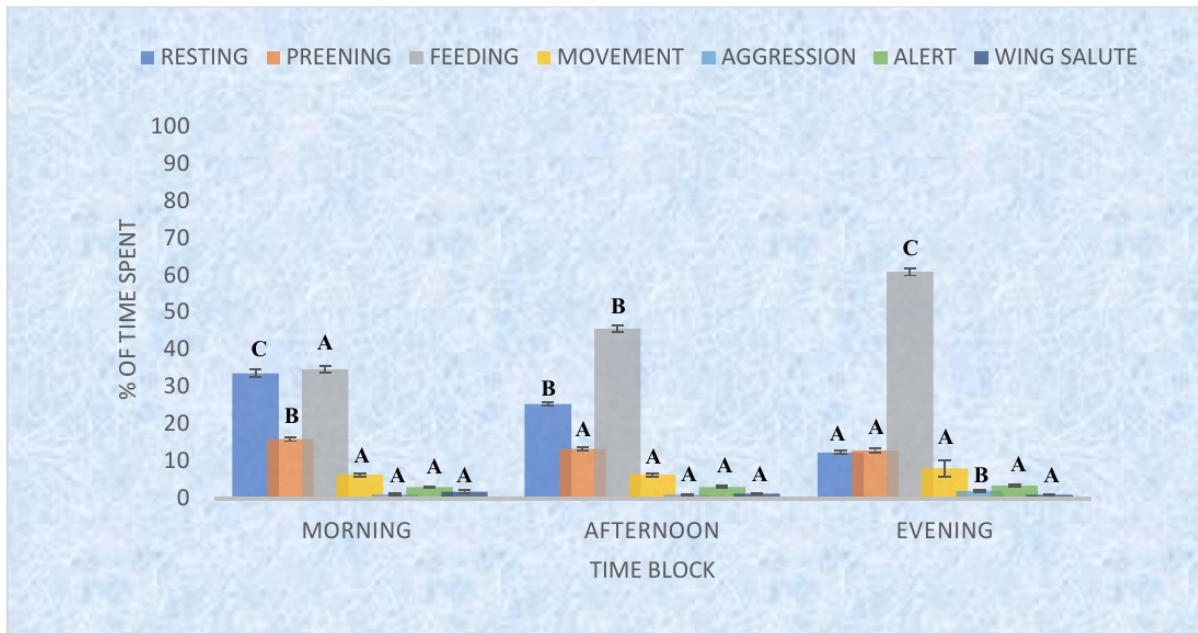


Figure 3. Activity pattern of Greater Flamingos throughout different time blocks of the day Najafgarh Jheel Bird Sanctuary. The bar of each activity among time blocks with the same letter are not significantly different in Accordance of Duncan’s test at 5 % probability.

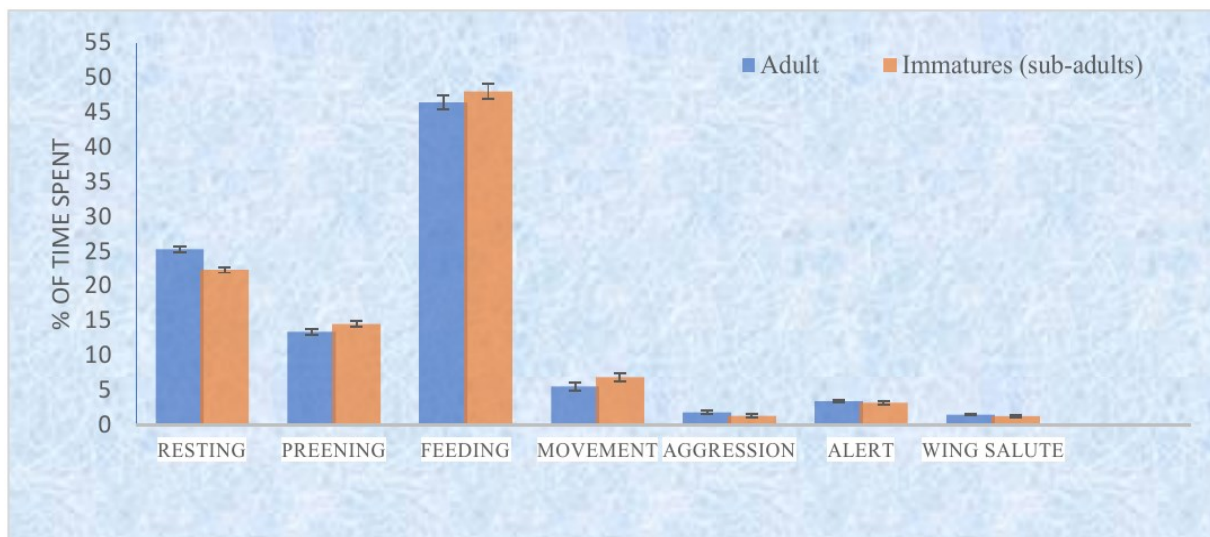


Figure 4. Overall comparison of % of time spent in Different type of activity Shown by Adult and Immature.

Table 2. % time spent by adult Greater Flamingo in performing various activities in Najafgarh Jheel Bird Sanctuary, Haryana, India from November 2018 through November 2019 in all three blocks (morning, afternoon and evening).

Time block	Number of observation days	Activity						
		Resting	Preening	Feeding	Movement	Aggression	Alert	Wing-salute
Morning	13	37.78 ^C	14.57 ^A	32.59 ^A	5.69 ^A	1.49 ^{AB}	3.29 ^A	2.46 ^A
Afternoon	13	26.10 ^B	13.42 ^A	45.15 ^B	6.05 ^A	1.21 ^A	3.52 ^A	1.49 ^A
Evening	13	12.16 ^A	13.14 ^A	61.50 ^C	9.71 ^A	2.44 ^B	3.63 ^A	1.12 ^A

* The mean is not different in columns denoted by the same letter ($P > 0.05$).

Table 3. % time spent by juvenile Greater Flamingo in performing various activities in Najafgarh Jheel Bird Sanctuary, Haryana, India from November 2018 through November 2019 in all three blocks (morning, afternoon and evening) of the day.

Time block	Number of observation days	Activity						
		Resting	Preening	feeding	Movement	Aggression	Alert	Wing-salute
Morning	13	29.59 ^C	17.41 ^B	37.03 ^A	7.09 ^A	0.88 ^A	3.04 ^A	1.29 ^A
Afternoon	13	24.85 ^B	13.33 ^A	46.18 ^B	6.73 ^A	0.96 ^A	2.87 ^A	1.23 ^A
Evening	13	12.63 ^A	12.68 ^A	60.53 ^C	6.60 ^A	1.65 ^A	3.45 ^A	1.11 ^A

* The mean is not different in columns denoted by the same letter ($P > 0.05$).

Statistical analysis shows that the proportion of time spent by adult flamingos throughout different time blocks of the day in resting and feeding was significantly different ($P < 0.05$) in morning afternoon and evening, while there was no difference ($P > 0.05$) in other activities such as preening movement alert among different time blocks of the day (Table 2)

Various behaviour patterns in immatures throughout different blocks of the day were found similar to adults for example feeding and resting were also found to be different ($P < 0.05$) during all three blocks of the day in immature similar to adults (table 3 and Figure 4).

The contrast between behaviours i.e., resting and feeding ($P < 0.05$) has been observed in all three blocks (morning, afternoon and evening) where, resting decreases in the afternoon and continue to decreases as the day progress, while feeding keep on increasing from morning till evening. Overall time used by flamingos (adults and immature) in performing most of the activities was not different ($P > 0.05$) among the different months. Behaviour associated with breeding (egg care, nest building and incubation) was not recorded at Najafgarh Jheel Bird Sanctuary as the breeding was not taken place at this site.

DISCUSSION

Time and energy expended on different activities can affect the birds state of survival. Time budgets can be adapted to different environments and is also the response to the aspects that affect the activities. The main activities of the Greater flamingo recorded during the present study were feeding resting and preening, these activities were also found to constitute most of the diurnal time in other species of flamingos for example in Caribbean Flamingos, (Espino-barros & Baldassarre, 1989); Lesser Flamingo, (Rameshchandra, 2014); and also, in other water wading birds such as oriental white stroke, (Shao *et al.*, 2015). During the study data was not collected associated with their feeding habits, however, they are found to feed on a large range of species of invertebrates, their larvae and eggs (Johnson & Cezilly, 2007). They are filter feeders even though they are found to be feed on fish, ragworm, and soldier crabs as well (Madon, 1932; Tere, 2005). Their feeding is not restricted to only invertebrates but also found to feed on

the seed of aquatic plants including rice (Madon, 1932; Abdulali, 1964), Chironomid larvae, blue-green algae few copepods and corixid (Ali, 1945; Ridley, 1954).

An activity budget study of any migratory species can also help to understand the importance of seasonal habitat use. The amount of food that birds need on a daily basis is influenced by their time budget, activity levels, and diet energy content (Kushlan, 1978). Feeding (47.16 ± 1.34) was one of the most observed activities in both adults as well as immature during all the times of day and among the months which indicates their efforts of collecting a large amount of small food as they filter feeder (Jenkin, 1957), and filter-feeding mode is one of the major reasons for their higher occurrence of feeding. There is a significantly difference ($P < 0.05$) in feeding in the morning afternoon and evening but the feeding was not much different ($P > 0.05$) between adults and immature and also among months. It was reported that feeding activities are highest in the morning and the evening (Cramp & Simmons, 1977, Espino-Barros & Baldassarre, 1989). No such patterns were found throughout the present study. Feeding was appeared to be affected by wind and tide variation because feeding effort in adults and immature significantly different ($P < 0.05$) throughout different time blocks of the day (figure-3 table- 2 & 3), a similar trend was noted in Lesser Flamingos at Kumbha Wada of Gujrat (Rameshchandra, 2014).

There was a very little time when adults and immature was to be found engaged in aggression during the study (Figure 4), no significant difference were recorded for time spent in aggression between adult and immature, a similar pattern was observed by Khaleghizadeh, (2010) in Greater Flamingos at the Persian Gulf, but the study on American Flamingos at Venezuela shows that the juveniles showed more aggressiveness than adults, aggressive encounter have had a huge impact on the amount of time spent in feeding by flamingos (Bildstein, *et.al.* 1991). The behaviour patterns in captive flamingos do vary over time, and they adapt to change in their local habitat (Rose, *et al.* 2018). Flamingos in their natural habitat shows change in habitat usage over time years (Arengo and Baldassarre, 2002) indicating their flexibility to change behaviour over time.

A study by Kumar and Rana (2021) shows that Najafgarh Jheel supports a huge population of Flamingos which was affected by several threats, so understanding of daily activity patterns of Greater Flamingos will be helpful to know their ability to adapt current habitat and strengthen long-term conservation and management plan for the species.

CONCLUSION

The present study on the Greater Flamingos, found at Najafgarh Jheel Bird Sanctuary (Drain) at Gurugram, Haryana, elaborates the Behaviour Patterns of these birds. Feeding resting and preening were major activities that were performed by the flamingos. Greater Flamingos were found to be present at Najafgarh Drain almost Throughout the year. Establishing this Drain as a wetland for the conservation of water birds would help protect the population of Greater Flamingos, along with other water birds and associated fauna and flora.

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Author's Contribution: The study was performed by both authors. Both authors helped to shape the research, analysis of data and manuscript.

Conflict of interest: The authors have no conflicts of interest. The manuscript's contents have been reviewed and approved by all co-authors.

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